I. Complete the following problems from the textbook:

Chapter 10 – Connection Elements

10-11

CHANGE BOLTS FROM PROB 9 to 7/8 in.

a) BOLT shear strength

$$\phi R_n = 6(24.3) = \underline{146^k}$$

Bearing and tearout. End bolts will still tearout

$$l_c = 1.25 - \tfrac{1}{2}\left(\tfrac{7}{8} + \tfrac{1}{16}\right) = 0.781 < 2\left(\tfrac{7}{8}\right)$$

$$1.2(0.781)\left(\tfrac{1}{2}\right)(58) = 27.2^k$$

$$2.4\left(\tfrac{7}{8}\right)\left(\tfrac{1}{2}\right)(58) = 60.9^k$$

$$\phi R_n = 0.75\big(2(27.2) + 4(60.9)\big) = \underline{224^k}$$

BOLT shear still controls

$$\phi R_n = \underline{\underline{146^k}}$$

10-18

CHANGE FROM Prob 17 is to $1\frac{1}{8}$ A490-X bolts

LRFD

BOLT SHEAR

$$\phi R_n = 6(2(62.6)) = 751^k$$

Bearing & TEAROUT

end bolts $l_c = 1.25 - \frac{1}{2}(1\frac{1}{8} + \frac{1}{16}) = 0.656 < 2d$

$$R_n = 1.2(0.656)(1.0)(58) = 45.7^k$$

INTERIOR bolts $l_c = 3.0 - (1\frac{1}{8} + \frac{1}{16}) = 1.81 < 2d$

$$R_n = 1.2(1.81)(1.0)(58) = 126^k$$

$$\phi R_n = 0.75(2(45.7) + 4(126)) = 447^k$$

TEAROUT CONTROLS

$$\phi R_n = \underline{447}^k$$

10-24

Bolt shear 3/4 in. A490-N

$\phi R_n = 8(22.5) = 180^k$

BEARING & TEAROUT WT flange thickness $t = 0.515$ in

$l_c = 1.5 - \frac{1}{2}(3/4 + 1/16) = 1.09 \text{ in.} < 2d$

$1.2(1.09)(0.515)(65) = 43.8^k$

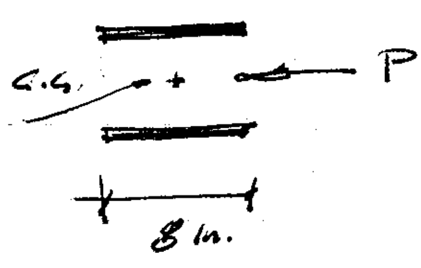
INTERIOR BOLTS

$2.4(3/4)(0.515)(65) = 60.3^k$

$\phi R_n = 0.75(2(43.8) + 6(60.3)) = \underline{337^k}$

Bolt shear controls $\phi R_n = \underline{\underline{180^k}}$

10-27

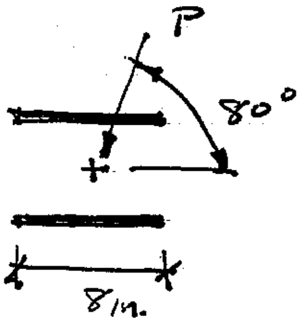


1/4 in. fillet weld (4 SIXTEENTHS)

E70 ELECTRODE

a) $\phi R_n = 8.0(2)(4)(1.392) = \underline{\underline{89.1^k}}$

10-31



FROM Prob 27

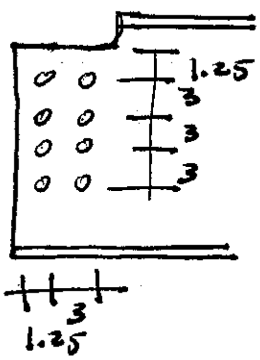
1/4 in.-fillet welds

Amplification
$$(1.0 + 0.5\sin^{1.5}(80)) = 1.49$$

a) $\phi R_n = 1.49(89.1) = 133^k$

10-38

W21X182 $t_w = 0.830$



$$A_{nt} = ((1.25+3) - 1.5(3/4 + 1/8))(0.83) = 2.44\,in^2$$

$$A_{gv} = (3+3+3+1.25)(0.83) = 8.51\,in^2$$

$$A_{nv} = 8.51 - 3.5(3/4 + 1/8)(0.83) = 5.97\,in^2$$

$U_{BS} = 0.5$

$$0.6F_y A_{gv} = 0.6(50)(8.51) = 255^k$$

$$0.6F_u A_{nv} = 0.6(65)(5.97) = 233^k *$$

$$F_u A_{nt} = (65)(2.44) = 159^k$$

a) $\phi R_n = 0.75(233 + 0.5(159)) = \underline{\underline{234^k}}$

DUE: Wednesday, November 25th

II. Answer the following problems:

1. One leg of an L 8 X 8 X 3/4 angle is to be connected with side welds and a weld at the end of the angle to a plate behind, to develop the loads P_D=170k and P_L=200k. Balance the fillet welds around the center of gravity of the angle. Determine weld lengths if E70 electrodes and maximum weld size is used.

II. Extra problems:

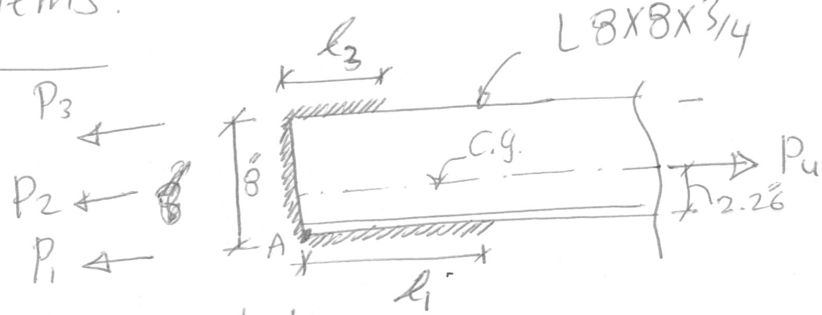
1.

$L8 \times 8 \times 3/4$

$P_D = 170^k$

$P_L = 200^k$

Use max weld size & E70 Electrodes



$P_u = 1.2P_D + 1.6\ P_L = 524^k$

Max weld size $= \frac{3}{4} - \frac{1}{16} = \frac{11}{16}''$

$\phi R_n = 1.392 * 11 = 15.31^{k/in}$

Since No info. is given in the problem statement about the base metal (Gusset plate), we skip checking strength (shear yield & shear rupture) of the base metal.

since we are asked to use both Longitudinal & transverse weld, we need to check two options (AISC J2.4c)

① $R_n = R_{wl} + R_{wt}$ (Both Long. & transverse have the same strength)

② $R_n = 0.85\, R_{wl} + 1.5\, R_{wt}$

① Total weld Length $= \frac{524^k}{15.31^{k/in}} = 34.33''$

$P_2 = 8 * 15.31 = 122.5^k$

Taking Moment about point A

$-122.5 * 4 - 8 * P_3 + 524 * 2.26'' = 0$

$\Rightarrow P_3 = 86.8^k$

$l_3 = \frac{86.8^k}{15.31^{k/in}} = 5.67''$

$P_1 = 524 - 86.8^k - 122.8 = 314.7^k$

$l_1 = \frac{314.7}{15.31} = 20.56''$ in

(2) Longi. weld strength $= 0.85 * 15.31 = 13.01^{k/in}$

Trans. " " $= 1.5 * 15.31 = 22.97^{k/in}$

$P_2 = 22.97 * 8 = 183.72^k$

Taking M a@ A:

$-183.72 * 4 - 8 * P_3 + 524 * 2.26'' = 0$

$\Rightarrow P_3 = 56.17 \Rightarrow l_3 = \frac{56.17^k}{13.01^{k/in}} = 4.32''$

$P_1 = 284.11^k \Rightarrow l_1 = \frac{284.11^k}{13.01} = 21.84''$

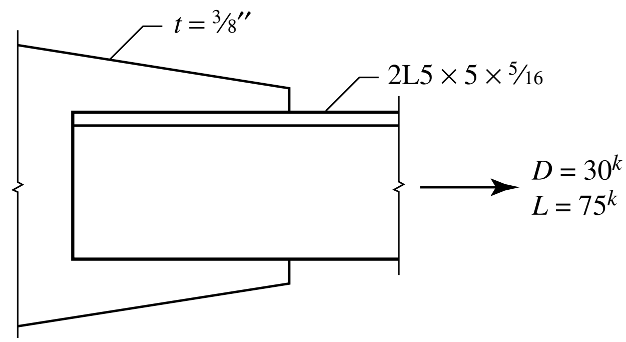
option (1) $l_1 + l_3 = 26.23'' \Rightarrow$ Controls

Option (2) $l_1 + l_3 = 26.16''$

$\boxed{\begin{array}{l} \text{Use } l_1 = 21'' \\ \text{Use } l_3 = 6'' \\ l_2 = 8'' \end{array}}$

DUE: Wednesday, November 25th

2. Design a welded connection for the connection shown below. The given loads are service loads. Use F_y of 50 ksi for the angle tension member and F_y of 36 ksi for the gusset plate. Show your results on a sketch with the weld dimensions shown on it.



From AISC Table J2.4, the minimum weld size is 3/16 inch (based on the angle thickness).
Maximum size = 5/16 − 1/16 = 1/4 in.

(a) LRFD solution: $P_u = 1.2D + 1.6L = 1.2(30) + 1.6(75) = 156.0$ kips

Try w = ¼ in., $\phi R_n = 1.392 \times 4$ sixteenths = 5.568 kips/in.

The base metal shear yield strength (gusset plate controls) is

$$0.6F_y t = 0.6(36)\left(\frac{3}{8}\right) = 8.1 \text{ kips/in.}$$

Shear rupture strength is $0.45F_u t = 0.45(58)\left(\frac{3}{8}\right) = 9.788$ kips/in.

Base metal shear yield strength for the angles is

$$0.6F_y t = 0.6(50)\left(\frac{5}{16} \times 2\right) = 18.75 \text{ kips/in.}$$

and the shear rupture strength is $0.45F_u t = 0.45(65)\left(\frac{5}{16} \times 2\right) = 21.94$ kips/in.

The weld strength of 5.568 kips/in. governs. Both longitudinal and transverse welds will be used. To determine the required length of the longitudinal welds, investigate the two options specified in AISC J2.4(c). First, assuming the same strength for both the longitudinal and transverse welds,

$$\text{total required length of weld} = \frac{156}{5.568} = 28.02 \text{ in.}$$

$$\text{length of longitudinal welds} = \frac{28.02 - 5}{2} = 11.51 \text{ in.}$$

For the second option, the strength of the longitudinal welds is

$$0.85(5.568) = 4.733 \text{ kips/in.}$$

and the strength of the transverse weld is

$$1.5(5.568) = 8.352 \text{ kips/in.}$$

The load to be carried by the longitudinal welds is

$$156 - 5(8.352) = 114.2 \text{ kips}$$

so the required length of the longitudinal welds is

$$\frac{114.2}{2(4.733)} = 12.06 \text{ in.}$$

Please note that in this problem the weld is not balanced around the connection. Equal longitudinal weld lengths is assumed. One could balance the weld around the connection in exactly the same manner as in the pervious problem.

The first option requires shorter longitudinal welds. Try a 5-inch transverse weld and two12-inch longitudinal welds. Check the block shear strength of the gusset plate.

$$A_{gv} = A_{nv} = 2 \times \frac{3}{8}(12) = 9.0 \text{ in.}^2 \qquad A_{nt} = \frac{3}{8}(5) = 1.875 \text{ in.}^2$$

$$R_n = 0.6F_u A_{nv} + U_{bs}F_u A_{nt} = 0.6(58)(9.0) + 1.0(58)(1.875) = 422.0 \text{ kips}$$

with an upper limit of

$$0.6F_yA_{gv} + U_{bs}F_uA_{nt} = 0.6(36)(9.0) + 1.0(58)(1.875) = 303.2 \text{ kips (controls)}$$

The design strength is

$$\phi R_n = 0.75(303.2) = 227 \text{ kips} > 156 \text{ kips} \qquad \text{(OK)}$$

<u>Use ¼-in. fillet welds as shown.</u>